

What is claimed is:

1. A package for optical micro-mechanical devices,
comprising:
5 a die comprising one or more optical micro-mechanical devices on
a first surface of a substrate, the first surface including a die reference surface;
a package frame comprising an aperture and a package frame
reference surface proximate the aperture adapted to receive the die reference
surface such that the optical micro-mechanical devices are located in the aperture;
10 one or more optical interconnect alignment mechanisms
terminating adjacent to the aperture are positioned relative to an optical interface
reference plane; and
distal ends of one or more optical interconnects located in the
optical interconnect alignment mechanisms and optically coupled with one or
15 more of the optical micro-mechanical devices.

2. The apparatus of claim 1 wherein the optical interface
reference plane comprises the die reference surface.

20 3. The apparatus of claim 1 wherein the optical interface
reference plane comprises the package frame reference surface.

25 4. The apparatus of claim 1 wherein the optical interface
reference plane comprises the plane parallel to the die reference surface located
between the die reference surface and the package frame reference surface.

5. The apparatus of claim 1 wherein the optical interconnect
alignment mechanisms comprise V-grooves located in the package frame
reference surface.

30 6. The apparatus of claim 1 wherein the optical interconnect
alignment mechanisms comprise V-grooves located in the die reference surface.

7. The apparatus of claim 1 wherein the optical interconnect alignment mechanisms are located in both the package frame reference surface and the die reference surface.

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8. The apparatus of claim 1 wherein the optical interconnects comprise a tangential relationship with the optical interface reference plane.

9. The apparatus of claim 1 wherein a first portion of an optical interconnect is positioned on one side of the optical interface reference plane and a second portion of the optical interconnect is positioned on another side of the optical interface reference plane.

10. The apparatus of claim 1 wherein at least one of the optical interconnects contacts the die.

✓ 11. The apparatus of claim 1 wherein the optical interconnects terminate adjacent to the die without contacting the die.

20 12. The apparatus of claim 1 wherein the optical interconnect comprises one of an optical fiber and optical fiber.

✓ 13. The apparatus of claim 12 wherein the lens optically couples the optical fiber with one or more optical micro-mechanical devices.

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✓ 14. The apparatus of claim 12 wherein the lens contacts the die.

✓ 15. The apparatus of claim 12 wherein the lens terminates adjacent to the die without contacting the die.

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16. The apparatus of claim 1 comprising one or more contact pads interposed between the die reference surface and the package frame reference surface.
- 5 ✓ 17. The apparatus of claim 16 comprising a contact pad on the die reference surface and a contact pad on the package frame reference surface.
18. The apparatus of claim 16 wherein the contact pad electrically couples one or more optical micro-mechanical devices with external electrical contacts.
- 10 19. The apparatus of claim 16 wherein the contact pad electrically couples one or more optical micro-mechanical devices with a flexible circuit member.
- 15 ✓ 20. The apparatus of claim 16 wherein the contact pad electrically couples one or more optical micro-mechanical devices with contact pads located on the package frame reference surface.
- 20 21. The apparatus of claim 1 wherein the aperture comprises a rectangular shape.
- 22. The apparatus of claim 1 wherein the aperture comprises a complex shape.
- 25 23. The apparatus of claim 1 wherein the aperture comprises a cross-shape configured so that the distal ends of the optical fibers terminate in arms of the cross-shaped aperture without contacting the die.
- 30 ✓ 24. The apparatus of claim 1 comprising a tooling fixture on a rear surface of the die.

25. The apparatus of claim 24 wherein the tooling fixture comprises a tooling post.

26. The apparatus of claim 24 wherein the tooling fixture comprises a heat sink.

27. The apparatus of claim 1 comprising an encapsulating material sealing the die to the package frame.

28. The apparatus of claim 1 comprising a cover sealing the die to the package frame.

29. The apparatus of claim 1 wherein the aperture comprises a cover.

30. The apparatus of claim 1 comprising a flexible circuit electrically coupled to the die.

31. The apparatus of claim 1 comprising electric traces on the package frame, the electric traces electrically coupled to contact pads in the package frame reference surface.

32. The apparatus of claim 1 comprising:
a flexible circuit extending across a rear surface of the die;
one or more vias extending through the die and electrically coupling the optical micro-mechanical devices to the flexible circuit.

33. The apparatus of claim 1 comprising:
a shoulder region adjacent to the optical micro-mechanical devices;
electrical traces extending from the optical micro-mechanical devices to the shoulder region; and

a flexible circuit located between the shoulder region and the optical interface reference plane, the flexible circuit being electrically coupled to the traces.

5 34. The apparatus of claim 1 wherein the package frame comprises:

one or more alignment posts positioned to engage with the die reference surface; and

10 a cavity adjacent to the alignment posts on a side opposite the aperture.

15 35. The apparatus of claim 34 comprising a flexible circuit extending through the cavity electrically couples with contact pads on the die reference surface.

36. The apparatus of claim 34 comprising an adhesive located in the cavity sufficient to retain the die to the alignment posts.

20 37. The apparatus of claim 1 comprising an optical communication system including at least one packaged optical micro-mechanical device.

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